J. Raptor Res. 35(2):124–129
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DISTRIBUTION OF WINTERING FERRUGINOUS HAWKS (*BUTEO REGALIS*) IN RELATION TO BLACK-TAILED PRAIRIE DOG (*CYNOMYS LUDOVICIANUS*) COLONIES IN SOUTHERN NEW MEXICO AND NORTHERN CHIHUAHUA

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ABSTRACT.—We studied winter habitat use of Ferruginous Hawks (*Buteo regalis*) from November 1999–February 2000 in southern New Mexico and northern Mexico by comparing vegetation in New Mexico among three potential hawk habitat types: occupied black-tailed prairie dog (*Cynomys ludovicianus*) colonies (N = 13), areas without prairie dogs that had historical records of occurrence (N = 7), and general grassland areas (N = 8). In Mexico, we recorded habitat use of hawks observed during driving surveys. Overall, 20 of 22 Ferruginous Hawks observed throughout the study were associated with occupied black-tailed prairie dog colonies. In New Mexico, we found the three site types were similar in vegetation composition and structure and differed only in the presence or absence of black-tailed prairie dogs; however, there were differences in the vegetation between hawk use areas in Mexico. Mexico sites had intensive grazing and less vegetation cover and overall shorter vegetation. Vegetation composition and structure did not seem to influence winter habitat selection in Ferruginous Hawks; instead, it was directly correlated with occupied black-tailed prairie dog colonies.

KEY WORDS: *Ferruginous Hawk*; Buteo regalis; *black-tailed prairie dog*; Cynomys ludovicianus; *wintering habitat.*

Distribucion de *Buteo regalis* durante el invierno en relación a las colonias de *Cynomys ludovicianus* en el sur de México y norte de Chihuahua

RESUMEN.—Estudiamos el uso de habitat de *Buteo regalis* desde Noviembre 1999–Febrero del 2000 en el sur de Nuevo México y norte de México mediante la comparación de la vegetación en Nuevo México entre tres tipos de habitats potenciales: Colonias ocupadas de *Cynomus ludovicianus* (N = 13), áreas sin perrillos de las praderas con registros históricos de ocurrencia (N = 7), y áreas de pastizales (N = 8). En México, registramos el uso de habitat de las rapaces observadas durante los conteos de carretera. En general, 20 de los 22 *Buteo regalis* observados a traves del estudio fueron asociados con colonias ocupadas por perrillos de las praderas. En Nuevo México, encontramos que los tres tipos de habitat fueron similares en su composición y estructura vegetal pero difirieron solamente en la presencia y ausencia de los perrillos de las praderas; sin embargo, hubo diferencias en la vegetación entre las áreas de uso en México. Los sitios de México tenían un pastoreo intensivo y menos cobertura vegetal y en general menos vegetación. La composición y estructura de vegetación no influenció la selección de habitat de invierno de *Buteo regalis*, por el contrario, estuvo directamente correlacionada con las colonias ocupadas por los perrillos de las praderas.

[Traducción de César Márquez]

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Ferruginous Hawks (*Buteo regalis*) winter primarily in grassland habitats from the southwestern United States (California to Oklahoma and Texas) to northern Mexico (Olendorff 1993, Bechard and Schmutz 1995). Primary winter prey includes rabbits (*Sylvilagus* spp.), hares (*Lepus* spp.), and prairie dogs (*Cynomys* spp.) (Schmutz and Fyfe 1987, Bechard and Schmutz 1995, Plumpton and Andersen 1997) making it an ecological specialist (Plumpton and Andersen 1998). Although much is known about its breeding biology, little has been published regarding the Ferruginous Hawk's winter biology (Plumpton and Andersen 1997). Migrant and wintering Ferruginous Hawks concentrate in prey-rich locations, principally prairie dog colonies (Clark et al. 1982, Schmutz and Fyfe 1987, Allison et al. 1995, Gietzen et al. 1997, Plumpton and Andersen 1998, Berry et al. 1998). Black-tailed prairie dog (*Cynomys ludovicianus*) colonies historically covered an estimated 40–283 million ha in North America (Seton 1929, Cully 1989, Knowles and Knowles 1994). Since the early 1900s, the black-tailed prairie dog has been the target of extensive eradication programs by private landowners, and state and federal agencies (Coppock et al. 1983, Miller et al. 1994). With these longstanding eradication programs and the continued conversion of grasslands into agricultural fields, the range of the black-tailed prairie dog has been reduced by 90–98% (Flath and Clark 1986, Miller et al. 1994).

In addition to prey reduction, Ferruginous Hawks face widespread grassland degradation that has caused overall population declines and localized extirpations (Woffinden and Murphy 1989, Olendorff 1993, Gietzen et al. 1997, Berry et al. 1998, Plumpton and Andersen 1998). In the southwestern United States, extensive overgrazing has shifted grasslands to shrublands (Dick-Peddie 1993). With continued increases in the human population, range degradation, invasion of nonnative plants, and fire control, loss of important grassland areas for the Ferruginous Hawk will undoubtedly continue (Humphrey 1952, Golkany 1998).

It is unknown if southern New Mexico is an important wintering ground for Ferruginous Hawks, although hawks banded in North Dakota and Alberta winter in western Texas and northern Mexico (Gilmer et al. 1985, Schmutz and Fyfe 1987). Much of the grassland habitat in southcentral New Mexico occurs on military installations that restrict public access, thereby reducing detection of these hawks. Because of this, we tested the hypothesis that greater relative numbers of wintering Ferruginous Hawks are associated with black-tailed prairie dog colonies as compared to areas that had historical prairie dog colonies (hereafter referred to as historic colonies), and semiarid grasslands. Our specific objectives were to assess habitat features used by wintering Ferruginous Hawks in southern New Mexico and adjacent Mexico.

STUDY AREAS

The New Mexico study area included portions of Doña Ana, Otero, Lincoln, Sierra, and Socorro counties. A total of 28 study sites (defined as a 300 m radius circle = 28.27 ha), were distributed among the United States Department of Agriculture's Jornada Experimental Range (JER, $N = 7$), White Sands Missile Range (WSMR, $N = 7$), and Fort Bliss Military Reservation ($N = 14$). The area is predominantly desert grassland with some sites intermixed with closed basin scrub (Dick-Peddie 1993).

Sites in the JER were in the Jornada del Muerto Basin and study sites averaged 1495 m elevation (range = 1306–1750 m). The area is Chihuahuan foothill-piedmont desert grassland and Chihuahuan broadleaf deciduous desert scrub, primarily composed of creosote bush (*Larrea tridentata*), black grama (*Bouteloua eriopoda*), and yuccas (*Yucca* spp.) (Thompson et al. 1996). Sites in the WSMR were in the Tularosa Basin and averaged 1200 m elevation (range = 1170–1300 m). Dominant vegetation included alkali sacaton (*Sporobolus airoides*)/tobosa grass (*Pleuraphis mutica*) grasslands and creosote bush/alkali sacaton shrublands (Muldavin et al. 1997). The Fort Bliss sites were on Otero Mesa and averaged 1800 m elevation (range = 1700–2000 m). Dominant vegetation included mesa grassland and basin/lowland desert grasslands that were primarily composed of blue grama (*Bouteloua gracilis*), soaptree yucca (*Yucca elata*), and alkali sacaton (Mehlhop et al. 1996).

The Mexico study area was located west of Janos in Chihuahua, approximately 55 km south of the United States-Mexico border. This area averaged 1250 m elevation (range = 1000–1300 m) and was coarsely classified as a Chihuahuan semidesert ecoregion (Bailey 1995). Dominant plant species at the study sites were Rothrock grama (*Bouteloua barbata* var. *rothrockii*), showy windmill grass (*Chloris verticillata*), and six-weeks three-awn (*Aristida adscensionis*). The surrounding area was comprised mainly of agricultural fields and pastureland.

METHODS

In New Mexico, we preselected three site types: occupied prairie dog colonies, historic prairie dog colonies, and general grasslands. We selected 28 sites (13 occupied, 7 historic, and 8 grassland) that we sampled during November 1999–February 2000.

The 13 occupied prairie dog colonies, all located on Fort Bliss, were recorded and mapped as part of a previous survey (unpubl. data). Seven historic colonies were delineated from available data and interviews with personnel familiar with the area (D. Holdermann pers comm., C. Oakes unpubl. data). Time since colonies were

last occupied varied from 1930–96 (E. Fredrickson pers. comm., D. Holdermann pers. comm.).

We selected grassland sites using a GIS model constructed using ArcView 3.1 and NT ArcInfo 7.03 (Environmental Systems Research Institute, Inc., Redlands, CA U.S.A.). The model included vegetation data from WSMR and Fort Bliss at 28.5-m pixel resolution and the JER at 90-m pixel resolution, which was the finest available resolution (Mehlhop et al. 1996, Thompson et al. 1996, Muldavin et al. 1997). We reviewed vegetation classification and dominant species to coarsely identify potential wintering grounds because information about Ferruginous Hawk winter habitat was limited. Model parameters were grassland vegetation classes and elevation <2256 m (Thompson et al. 1996). These areas were combined into two GIS coverages because of different resolution and study sites were randomly selected from the coverages. All sites were located in the field using a handheld Trimble GeoExplorer II GPS receiver (Trimble Navigation, Sunnyvale, CA U.S.A.).

We randomly selected five of each site type (occupied colony, historic colony, and grassland) to determine if they were used by Ferruginous Hawks. We visited the sites in random order either in the morning (0830–1130 H) or afternoon (1200–1500 H). Observations consisted of a 3-hr recording of Ferruginous Hawk presence and habitat use (Fuller and Mosher 1987). Coinciding with the site observation, a 3-hr road survey was conducted of the surrounding area, including 2–4 adjacent predetermined sites (Fuller and Mosher 1987, Craig 1982). To be considered as using a habitat, a hawk had to be in view of the observer for a minimum of 3 min.

Restricted sampling time and little or no historical information on black-tailed prairie dogs limited the Mexico portion of this research to road surveys. We conducted surveys during 5–11 January 2000 on a 24-km route. The route was a mosaic of occupied black-tailed prairie dog colonies and potentially suitable desert grassland areas. Road survey methods were similar in Mexico and the New Mexico study areas.

Data on vegetation was collected at the center of each site. For sites that had associated GIS coverages (eight occupied prairie dog colonies and three of seven historic colonies), we used ArcView 3.1 to determine the geometric center of the site. We estimated the center of the remaining four historic colonies from historical information and used the randomly selected points from the grassland GIS model for the center of sites without prairie dogs.

From the center point of each site, we selected a random azimuth and delineated a 300-m transect. Two additional 300-m transect lines were placed 120° on either side of the original line. We collected data at 10-m intervals using a modified step-point method (Evans and Love 1957). At each 10-m point, we recorded the species or substrate. Within a 1-m radius of the point, minimum and maximum grass and forb height were measured with a meter rule. Within a 3-m radius, minimum and maximum shrub heights were measured with a 1-m rule.

For hawks observed during either road or point surveys, the center point for vegetation sampling was determined based on the hawk's behavior. If it was soaring for any part of the observation, the habitat it flew over was delineated on a 1:24 000 topographic map. After mapping this area, a 0.16-km grid was placed over it and a random center point was selected. For hawks perched for the duration of the observation, the perch site was used as the center for vegetation data collection.

For the New Mexico observations among the three site types, we compared percent cover by growth form (grass, forb, and shrub) and percent bare ground among the sites. We also compared minimum and maximum vegetation heights based on growth form. Lastly, we selected the five dominant cover forms (plant or bare ground) from the New Mexico hawk observations and compared the percent composition of those categories among sites

Mexico hawk observations were compared to New Mexico hawk observations using only vegetation heights and percent cover by growth form because of differences in plant communities. Dominant cover types were not compared between New Mexico and Mexico sites.

To test for statistical differences among sites, we used general linear models (PROC GLM; SAS Institute 1988). We analyzed vegetation height and percent cover using analysis of variance (ANOVA). We further analyzed percent cover and vegetation heights showing significant differences using the Fisher least significant difference (LSD) test to identify which site types differed. To test for the percent cover of the dominant species, we used multiple ANOVA on a transformed variable ($\sqrt{\text{arcsine}}$ [%]) because percent data typically do not follow a normal distribution.

RESULTS

We conducted observations for a total of 130 hrs (90 hrs in New Mexico and 40 hrs in Mexico) from November 1999–February 2000. We observed 22 Ferruginous Hawks in New Mexico ($N = 7$) and Mexico ($N = 15$). In New Mexico, we observed hawks at the rate of one hawk/12.86 hr, while in Mexico we observed one hawk/2.67 hr. In New Mexico, five hawks were observed on or over prairie dog colonies and two were over desert grasslands. In Mexico, all 15 observations were on or over prairie dog colonies.

In New Mexico, predetermined site types and actual hawk habitat use did not differ in percent cover of grass, forbs, shrubs, or bare ground. Habitat features at hawk use areas in Mexico differed from sites in New Mexico. Mexico sites averaged higher percentages of bare ground ($F_{1,20} = 13.32$, $P = 0.002$) than the New Mexico sites due to little or no grazing management in Mexico. There were higher percentages of shrubs ($F_{1,20} = 26.03$, $P = 0.0001$) and forbs ($p = 0.038$, $F_{1,20} = 4.95$, $P = 0.038$) at sites that were used by hawks in New Mexico than in Mexico. Overall, grass cover did not differ between sites.

Vegetation height at sites used by hawks in New Mexico had the greatest similarity to vegetation

features measured in occupied prairie dog colonies. Occupied colonies and New Mexico hawk use sites (5 of 7 at occupied colonies) had shorter grass than the other site types ($T = 2.04$, df = 31), likely resulting from prairie dog herbivory. Shrub heights varied among the sites and differed between historic colonies and grassland sites ($T = 2.04$, df = 31). Forb heights were similar among all sites.

Minimum ($F_{1,20} = 6.14$, $P = 0.022$) and maximum ($F_{1,20} = 24.00$, $P = 0.0001$) grass heights were lower in Mexico compared to sites used by hawks in New Mexico likely due to intense grazing. Grazing intensity also reduced maximum heights of forbs at the Mexico sites ($p = 0.0006$, $F_{1,20} = 16.52$, $P = 0.0006$). Shrub heights in Mexico were similar to those of hawk use sites in New Mexico, but the overall sample of shrubs in Mexico was small (0.52% of total cover).

The five cover categories with the highest cover at New Mexico hawk use sites were bare ground (39.1% ± 1.1), blue grama (*Bouteloua gracilis,* 14.0% ± 1.6), black grama (*B. eriopoda,* 8.1% ± 0.9), burro grass (*Scleropogon brevifolius,* 6.4% ± 0.9), and tobosa grass (6.4% ± 1.3). Percentages of dominant species did not differ among New Mexico sites. Percent bare ground differed ($F_{1,13} = 7.07$, $P = 0.02$) between hawk observations in New Mexico and general grassland sites (28.2% ± 1.0).

DISCUSSION

Although occupied prairie dog colonies comprised a small percentage of available habitat, 20 of the Ferruginous Hawks we observed were associated with prairie dog colonies. On Fort Bliss, occupied prairie dog colonies accounted for <0.01% of 74 172 ha of the Otero Mesa grassland complex and comprised <35.0% of the 15 New Mexico study sites. In Mexico, occupied prairie dog colonies accounted for <5% of the area surveyed. Plumpton and Andersen (1997) reported Ferruginous Hawk winter habitat to be characterized by occupied prairie dog colonies in Colorado. When prairie dogs did not occur, Eakle et al. (1996) found that wintering Ferruginous Hawks in southwestern New Mexico used plains grassland habitat. Our data suggest that occupied black-tailed prairie dog colonies are important for wintering Ferruginous Hawks both in southern New Mexico and northern Mexico.

We observed two hawks unassociated with prairie dog colonies on 27 November and 12 February in New Mexico over desert grassland and grassland/scrubland habitats. Migration surveys about 115–160 km to the north have reported that the migration of Ferruginous Hawks occurs in fall between 1 September–1 November and in spring between 22 February–28 April (J. Smith pers. comm.). Thus, we assumed our late-November and mid-February sightings were migrants because no other Ferruginous Hawks were seen in those areas during winter.

Other researchers have found differences in dominant plant species due to prairie dog activity. Weltzin et al. (1997) found that warm season C_4 grasses, such as sand dropseed (*Sporobolus cryptandrus*), dominated off-colony zones while shortgrass C_4 grasses, such as burro grass (*Dasyochloa pulchella*), were more common on colonies. Similarly, grassland sites in our study averaged 19.4% sand dropseed, while sites used by hawks in New Mexico averaged 3.8% sand dropseed. Grassland sites also had fewer areas of bare ground (28.2%) than did sites used by hawks in New Mexico (39.1%).

Mexico sites were heavily grazed, but had high use by Ferruginous Hawks primarily due to the presence of black-tailed prairie dogs. The New Mexico sites received less grazing intensity, but were used less by Ferruginous Hawks. Prairie dog colonies in Mexico were large and expansive, averaging >20 ha, as compared to the New Mexico prairie dog colonies that averaged only about 10 ha. Gietzen et al. (1997) reported declines in wintering hawks and eagles as populations of black-tailed prairie dogs fluctuated due to sylvatic plague. Plumpton and Andersen (1997) reported that wintering Ferruginous Hawks were increasingly tolerant of human disturbance and habitat fragmentation if prairie dogs were present. Our data suggest that declines of Ferruginous Hawks in the west could continue if fragmentation and eradication of black-tailed prairie dog colonies continues throughout the wintering range of the Ferruginous Hawk (Woffinden and Murphy 1989).

Overall, we found that vegetation composition and structure did not influence habitat use by wintering Ferruginous Hawks. Similarities in habitats used in Mexico and New Mexico appeared to be due to the presence of black-tailed prairie dogs. The occurrence of Ferruginous Hawks in the New Mexico study sites was also correlated with the presence of prairie dogs stressing the importance of black-tailed prairie dog colonies to wintering Ferruginous Hawks.

Northern Mexico may be an important wintering ground for the Ferruginous Hawk, but it has minimal, if any, protection. The Janos area is grazed heavily and black-tailed prairie dogs are poisoned by ranchers (K. Young pers. comm.). Ferruginous Hawks in the Janos area also are at risk of electrocution. Uninsulated electrical wires killed four Golden Eagles (*Aquila chrysaetos*) and one Ferruginous Hawk in January 2000. In 1996, a group from Universidad Nacional Autonoma de Mexico started an effort to set aside a large protected area in northern Chihuahua to preserve the prairie dog colonies and species associated with them (Miller 1996).

ACKNOWLEDGMENTS

We thank C. Benkman, B. Locke, and M. Andersen for their review of earlier manuscripts and insightful comments. We also thank the Army Environmental Center and T&E, Inc. for funding this research. New Mexico State University's Agricultural Experiment Station provided additional financial support.

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Received 27 July 2000; accepted 19 February 2001